

WHAT IS CLAIMED IS

1. An optical-pickup slider, comprising:  
5 a layer; and  
a light-transmitting-property substrate,  
wherein:  
said layer has a tapered through hole; and  
said light-transmitting-property substrate is  
10 bonded to a surface of said layer, on which surface a  
larger opening of said tapered through hole exists.
2. The optical-pickup slider as claimed in  
15 claim 1, wherein said light-transmitting-property  
substrate has a thickness at least ten times a thickness  
of said layer.

3. The optical-pickup slider as claimed in claim 1, wherein glass or  $\text{TiO}_2$  is used as a material of said light-transmitting-property substrate when a wavelength of light to be incident is on the order of 2  
5  $\mu\text{m}$  to the order of  $0.4 \mu\text{m}$ , but quartz glass,  $\text{MgO}$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Y}_2\text{O}_3$  or diamond is used as a material of said light-transmitting-property substrate when a wavelength of light to be incident is equal to or shorter than  $0.4 \mu\text{m}$ .

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4. The optical-pickup slider as claimed in claim 1, wherein a non-light-transmitting film is  
15 provided at least on an inclined surface of said tapered through hole.

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5. The optical-pickup slider as claimed in claim 4, wherein said non-light-transmitting film is made of metal or resistivity-lowered semiconductor.

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6. The optical-pickup slider as claimed in claim 4, wherein said non-light-transmitting film is made of eutectic of metal and said layer.

5

7. The optical-pickup slider as claimed in claim 4, wherein:

Si is used as a material of said layer; and

10 said non-light-transmitting film is formed as a result of resistivity of at least the inclined surface of said tapered through hole being lowered.

15

8. An optical-pickup slider comprising:

a first substrate;

a layer layered on said first substrate and having a thickness smaller than that of said first substrate,

wherein:

a tapered through hole is made in said layer;  
and

after a light-transmitting-property substrate is  
bonded to a surface of said layer, said first substrate is  
5 removed so that an aperture at a tip of said tapered  
through hole is exposed.

9. An optical-pickup slider comprising:

a first substrate;

10 a layer layered on said first substrate and  
having a thickness smaller than that of said first  
substrate,

wherein:

a tapered through hole is made in said layer;  
15 and

after a light-transmitting-property substrate is  
bonded to a surface of said layer, said first substrate is  
removed, and, then, a ski shape or a pad shape is made in  
said layer at a position of an aperture at a tip of said  
20 tapered through hole.

10. An optical-pickup slider comprising:

a first substrate;

a layer layered on said first substrate and  
having a thickness smaller than that of said first  
5 substrate,

wherein:

a ski shape or a pad shape having a tapered  
through hole is made in said layer; and

after a light-transmitting-property substrate is  
10 bonded to a surface of said layer, said first substrate is  
removed so that an aperture at a tip of said tapered  
through hole is exposed.

11. An optical-pickup slider comprising:

15 a first substrate;

a layer layered on said first substrate and  
having a thickness smaller than that of said first  
substrate,

wherein:

20 a tapered through hole is made in said layer;  
and

after a film-of a non-light-transmitting-property material is provided on at least an inclined surface of said tapered through hole, a light-transmitting-property substrate is bonded to a surface of said layer, and, after said first substrate is removed, a portion of the non-light-transmitting-property material is removed at an aperture at a tip of said tapered through hole so that said aperture is exposed.

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12. A method of manufacturing an optical-pickup slider comprising the steps of:

a) making a tapered through hole in a layer layered on a first substrate and having a thickness smaller than that of said first substrate; and

b) after bonding a light-transmitting-property substrate to a surface of said layer, removing said first substrate so as to expose an aperture at a tip of said tapered through hole.

13. A method of manufacturing an optical-pickup slider comprising the steps of:

a) making a tapered through hole in a layer layered on a first substrate and having a thickness  
5 smaller than that of said first substrate; and

b) after bonding a light-transmitting-property substrate to a surface of said layer, removing said first substrate, and, then, making a ski shape or a pad shape in said layer at a position of an aperture at a tip of said  
10 tapered through hole.

14. A method of manufacturing an optical-pickup slider comprising the steps of:

15 a) making a ski shape or a pad shape having a tapered through hole in a layer layered on a first substrate and having a thickness smaller than that of said first substrate; and

b) after bonding a light-transmitting-property  
20 substrate to a surface of said layer, removing said first substrate so as to expose an

aperture at a tip of said tapered through hole.

15. A method of manufacturing an optical-pickup  
5 slider comprising the steps of:

a) making a tapered through hole in a layer  
layered on a first substrate and having a thickness  
smaller than that of said first substrate; and

b) after providing a film of a non-light-  
10 transmitting-property material on at least an inclined  
surface of said tapered through hole, bonding a light-  
transmitting-property substrate to a surface of said  
layer, and, after removing said first substrate, removing  
a portion of the non-light-transmitting-property material  
15 at an aperture at a tip of said tapered through hole so as  
to expose said aperture.

16. A method of manufacturing an optical-

pickup slider comprising the steps of:

a) making a tapered through hole in a layer layered on a first substrate and having a thickness smaller than that of said first substrate; and

5           b) after forming eutectic of metal and said layer on at least an inclined surface of said tapered through hole, bonding a light-transmitting-property substrate to a surface of said layer, and removing said first substrate so as to expose an aperture at a tip of  
10 said tapered through hole.

17. A method of manufacturing an optical-pickup slider comprising the steps of:

15           a) making a tapered through hole in an Si layer layered on a first substrate and having a thickness smaller than that of said first substrate; and

            b) after lowering resistivity of a surface of at least an inclined surface of said tapered through hole,  
20 bonding a light-transmitting-property substrate to a surface of said layer, and removing

said first substrate so as to expose an aperture at a tip of said tapered through hole.

5

18. A probe comprising:

a substrate having a property of transmitting light; and

10 a projecting portion formed on said substrate, and made of a material having a refractive index higher than that of said substrate,

wherein said projecting portion has light from said substrate incident thereon, and generates one of or  
15 both an optical near-field and propagation light at a tip thereof.

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19. The probe as claimed in claim 18, wherein said projecting portion is made of a single-crystal material having a refractive index higher than that of said substrate.

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20. The probe as claimed in claim 18, wherein said projecting portion is made of a single-crystal Si (silicon) having a refractive index higher than that of said substrate.

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21. The probe as claimed in claim 18, wherein  
10 said projecting portion is made from a Gap layer.

15 22. The probe as claimed in claim 18, wherein said projecting portion is made of a material obtained as a result of a predetermined amount of impurities being mixed to a material having a refractive index higher than that of said substrate.

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23. The probe as claimed in claim 18, wherein  
25 said projecting portion is made of an n-type Si material

having a refractive index higher than that of said substrate.

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24. The probe as claimed in claim 18, wherein said projecting portion is made of a high-concentration p-type Si material having a refractive index higher than  
10 that of said substrate.

15 25. The probe as claimed in claim 18, wherein said projecting portion has a plurality of tapering angles on an outer wall thereof.

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26. The probe as claimed in claim 18, further comprising a bank portion having the same height as that of said projecting portion and arranged to surround said  
25 projecting portion.

27. The probe as claimed in claim 18, further comprising a bank portion made of the same material as that of said projecting portion and arranged to surround said projecting portion.

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28. The probe as claimed in claim 18,  
10 wherein:

a rotating recording medium, on which information is recorded, is arranged at a tip of said projecting portion; and

said probe further comprises a bank portion  
15 arranged to surround said projecting portion and having an opening provided in a direction in which air flows due to rotation of the rotating recording medium.

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29. The probe as claimed in claim 28, wherein said projecting portion is located at a position such that a tip of said projecting portion and an end of said  
25 bank portion in a rotating-recording-medium-going-out

direction coincide with one another in a direction perpendicular to a rotating-recording-medium-coming-in direction, or at a position such that said tip of said projecting portion is located on a rotating-recording-medium-coming-in side of said end of said bank portion.

10                   30. The probe as claimed in claim 28, wherein said bank portion has a tapered portion, inclined from a rotating-recording-medium-coming-in side of said substrate to a rotating-recording-medium-going-out side of said substrate, at an end thereof in a rotating-recording-medium-going-out direction.

20                   31. The probe as claimed in claim 28, wherein said bank portion has a tapered portion, inclined from a rotating-recording-medium-coming-in side of said substrate to a rotating-recording-medium-going-out side of said substrate, at a bank thereof in a rotating-recording-medium-coming-in direction.

32. The probe as claimed in claim 28, wherein  
said bank portion has a tapered portion, inclined in a  
radial direction of the rotating recording medium, at a  
bank(s) approximately parallel to a rotating-recording-  
5 medium-coming-in direction.

10 33. The probe as claimed in claim 28, wherein  
a length between an end of said substrate on a rotating-  
recording-medium-going-out side and a tip of said  
projecting portion is determined based on a thickness  
thereof, a refractive index thereof and a numerical  
15 aperture of an optical component from which light is  
incident.

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34. The probe as claimed in claim 18,  
wherein:

a rotating recording medium, on which  
information is recorded, is arranged at a tip of said  
25 projecting portion; and

said probe further comprises: a bank portion made of the same material as that of said projecting portion, having the same height as that of said projecting portion and arranged to surround said projecting portion; and a pad portion made of the same material as that of said projecting portion, having the same height as that of said projecting portion and coming into contact with a facing side of the rotating recording medium.

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35. The probe as claimed in claim 34, wherein said pad portion is formed at a central position between a rotating-recording-medium-coming-in end and a rotating-recording-medium-going-out end of said substrate, or at a position in a range between  $\pm 0.1$  from said central position assuming that an entire length of said substrate is 1.

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36. The probe as claimed in claim 18, wherein

a light-blocking film is formed on said projecting portion and a side of said substrate on which said projecting portion is formed, or only on said projecting portion:

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37. The probe as claimed in claim 18, wherein  
10 a light-blocking film is formed on an inclined surface of said projecting portion and a side of said substrate on which said projecting portion is formed, or only on the inclined surface of said projecting portion.

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38. A method of manufacturing a probe comprising the steps of:

20 a) bonding together a first substrate having a property of transmitting light and a second substrate comprising a high-refractive-index layer having a refractive index higher than that of said first substrate, an intermediate layer layered on said high-  
25 refractive-index layer and a supporting layer layered on

said intermediate layer, in a condition in which said first substrate is in contact with said high-refractive-index layer;

5       b) removing said supporting layer included in said second substrate;

      c) patterning by said intermediate layer exposed as a result of said supporting layer being removed;

10       d) etching said high-refractive-index layer using the patterned intermediate layer so as to form a cone-like or pyramid-like projecting portion on said first substrate; and

15       e) removing the patterned intermediate layer so that the probe having the cone-like or pyramid-like projecting portion made from said high-refractive-index layer on said first substrate be obtained.

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      39. The method as claimed in claim 38, wherein said high-refractive-index layer is of Si and said intermediate layer is of SiO<sub>2</sub>.

25

40. The method as claimed in claim 38,  
wherein said high-refractive-index layer is of GaP and  
said intermediate layer is of SiO<sub>2</sub>.

5

41. The method as claimed in claim 38,  
wherein said high-refractive-index layer is of a single-  
10 crystal material, said intermediate layer is of SiO<sub>2</sub> and  
said supporting layer is of Si.

15

42. The method as claimed in claim 38,  
wherein said high-refractive-index layer is of a single-  
crystal Si, said intermediate layer is of SiO<sub>2</sub> and said  
supporting layer is of Si.

20

43. The method as claimed in claim 38,  
25 wherein, in the etching, the projecting portion is

formed so as to have a plurality of tapering angles on  
an outer wall thereof.

5

44. The method as claimed in claim 38,  
wherein, in the etching, a bank portion having the same  
height as that of said projecting portion and arranged  
10 to surround said projecting portion is further formed.

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45. The method as claimed in claim 38,  
wherein etching is performed on the same high-  
refractive-index layer and a bank portion having the  
same height as that of said projecting portion and  
arranged to surround said projecting portion is further  
20 formed.

25

46. The method as claimed in claim 38,

wherein:

said probe is such that a rotating recording medium, on which information is recorded, is arranged at a tip of said projecting portion; and

5 in the etching, a bank portion arranged to surround said projecting portion and having an opening provided in a direction, in which air flows due to rotation of the rotating recording medium, is further formed.

10

47. The method as claimed in claim 46,  
15 wherein said bank portion has a tapered portion, inclined from a rotating-recording-medium-coming-in side of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at an end thereof in a rotating-recording-medium-going-out  
20 direction.

25 48. The method as claimed in claim 46,

wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
going-out side of said first substrate, at a bank  
5 thereof in a rotating-recording-medium-coming-in  
direction.

10

49. The method as claimed in claim 46,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording  
medium, at a bank(s) approximately parallel to a  
15 rotating-recording-medium-coming-in direction.

20

50. The method as claimed in claim 46,  
wherein a length between an end of said first substrate  
in a rotating-recording-medium-going-out direction and a  
tip of said projecting portion is determined based on a  
thickness thereof, a refractive index thereof and a  
25 numerical aperture of an optical component from which

light is incident.

5

51. The method as claimed in claim 38,

wherein:

said probe is such that a rotating recording  
medium on which information is recorded is arranged at a  
10 tip of said projecting portion; and

etching is performed on the same high-  
refractive-index layer, and, said projecting portion, a  
bank portion arranged to surround said projecting  
portion and a pad portion coming into contact with the  
15 rotating recording medium are formed on a side of said  
first substrate facing the rotating recording medium.

20

52. The method as claimed in claim 51,  
wherein said pad portion is formed at a central position  
between a rotating-recording-medium-coming-in end and a  
rotating-recording-medium-going-out end of said first  
25 substrate, or at a position in a range between  $\pm 0.1$

from said central position assuming that an entire length of said first substrate is 1.

5

53. The method as claimed in claim 38, wherein, after said intermediate layer is removed, a light-blocking film is formed on said projecting portion and a side of said substrate on which said projecting portion is formed, or only on said projecting portion.

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54. The method as claimed in claim 38, wherein, after said intermediate layer is removed, a light-blocking film is formed on an inclined surface of said projecting portion and a side of said substrate on which said projecting portion is formed, or only on the inclined surface of said projecting portion.

25

55. The method as claimed in claim 38,  
wherein, when patterning is performed by said  
intermediate layer, said intermediate layer is to have a  
predetermined thickness at a position of a tip of said  
5 projecting portion to be made and said intermediate  
layer at positions other than that of the tip of said  
projecting portion is to have a thickness equal to or  
smaller than said predetermined thickness.

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56. A method of manufacturing a probe  
comprising the steps of:

15 a) bonding together a first substrate having a  
property of transmitting light and a second substrate  
comprising a supporting layer, an intermediate layer  
formed on said supporting layer and a GaP layer formed  
on said intermediate layer, in a condition in which said  
20 first substrate and said GaP layer are in contact with  
one another;

b) removing said supporting layer included in  
said second substrate;

c) patterning by said intermediate layer;  
25 exposed as a result of said supporting layer being

removed;

d) etching said GaP layer using the patterned intermediate layer so as to form a cone-like or pyramid-like projecting portion on said first substrate; and

5 e) removing the patterned intermediate layer so that the probe having the cone-like or pyramid-like projecting portion made from said GaP layer on said first substrate be obtained.

10

57. The method as claimed in claim 56, wherein, in the etching, the projecting portion is  
15 formed so as to have a plurality of tapering angles on an outer wall thereof.

20

58. The method as claimed in claim 56, wherein, in the etching, a bank portion having the same height as that of said projecting portion and arranged to surround said projecting portion is further formed.

25

59. The method as claimed in claim 56,  
wherein etching is performed on the same GaP layer and a  
bank portion made of the same material as that of said  
projecting portion and arranged to surround said  
5 projecting portion is further formed.

10 60. The method as claimed in claim 56,  
wherein:  
said probe is such that a rotating recording  
medium, on which information is recorded, is arranged at  
a tip of said projecting portion; and

15 in the etching, a bank portion arranged to  
surround said projecting portion and having an opening  
provided in a direction in which air flows due to  
rotation of the rotating recording medium, is further  
formed.

20

61. The method as claimed in claim 60,  
25 wherein said bank portion has a tapered portion,

inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
going-out side of said first substrate, at an end  
thereof in a rotating-recording-medium-going-out  
5 direction.

10                   62. The method as claimed in claim 60,  
wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
going-out side of said first substrate, at a bank  
15 thereof in a rotating-recording-medium-coming-in  
direction.

20                   63. The method as claimed in claim 60,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording  
medium, at a bank(s) approximately parallel to a  
25 rotating-recording-medium-coming-in direction.

64. The method as claimed in claim 60,  
wherein a length between an end of said first substrate  
in a rotating-recording-medium-going-out direction and a  
tip of said projecting portion is determined based on a  
5 thickness thereof, a refractive index thereof and a  
numerical aperture of an optical component from which  
light is incident.

10

65. The method as claimed in claim 56,  
wherein:

said probe is such that a rotating recording  
15 medium on which information is recorded is arranged at a  
tip of said projecting portion; and

etching is performed on the same GaP layer,  
and, said projecting portion, a bank portion arranged to  
surround said projecting portion and a pad portion  
20 coming into contact with the rotating recording medium  
are formed on a side of said first substrate facing the  
rotating recording medium.

25

66. The method as claimed in claim 65,  
wherein said pad portion is formed at a central position  
between a rotating-recording-medium-coming-in end and a  
rotating-recording-medium-going-out end of said first  
5 substrate, or at a position in a range between  $\pm 0.1$   
from said central position assuming that an entire  
length of said first substrate is 1.

10

67. The method as claimed in claim 56,  
wherein, after said intermediate layer is removed, a  
light-blocking film is formed on said projecting portion  
15 and a side of said substrate on which said projecting  
portion is formed, or only on said projecting portion.

20

68. The method as claimed in claim 56,  
wherein, after said intermediate layer is removed, a  
light-blocking film is formed on an inclined surface of  
said projecting portion and a side of said substrate on  
25 which said projecting portion is formed, or only on the

inclined surface of said projecting portion.

5

69. The method as claimed in claim 56,  
wherein, when patterning is performed by said  
intermediate layer, said intermediate layer is to have a  
predetermined thickness at a position of a tip of said  
10 projecting portion to be made and said intermediate  
layer at positions other than that of the tip of said  
projecting portion is to have a thickness equal to or  
smaller than said predetermined thickness

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70. A method of manufacturing a probe  
comprising the steps of:

20 a) bonding together a first substrate having a  
property of transmitting light and a second substrate  
comprising a low-concentration layer having a refractive  
index higher than that of said first substrate and  
having a predetermined amount of impurities mixed  
25 therein and a high-concentration layer having impurities

more than said predetermined amount of impurities mixed therein, in a condition in which said first substrate and said low-concentration layer are in contact with one another;

5                   b) removing said high-concentration layer included in said second substrate;

                  c) forming a patterning material on a surface of said low-concentration layer exposed as a result of said high-concentration layer being removed and  
10                   patterning by said patterning material;

                  d) etching said low-concentration layer using the patterned patterning material so as to form a cone-like or pyramid-like projecting portion on said first substrate; and

15                   e) removing the patterned patterning material so that the probe having the cone-like or pyramid-like projecting portion made from said low-concentration layer on said first substrate be obtained.

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71. The method as claimed in claim 70,  
wherein, in the etching, the projecting portion is  
25                   formed so as to have a plurality of tapering angles on

an outer wall thereof.

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72. The method as claimed in claim 70,  
wherein, in the etching, a bank portion having the same  
height as that of said projecting portion and arranged  
to surround said projecting portion is further formed.

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73. The method as claimed in claim 70,  
15 wherein etching is performed on the same low-  
concentration layer and a bank portion made of the same  
material as that of said projecting portion and arranged  
to surround said projecting portion is further formed.

20

74. The method as claimed in claim 70,  
wherein:

25 said probe is such that a rotating recording

medium, on which information is recorded, is arranged at a tip of said projecting portion; and

in the etching, a bank portion arranged to surround said projecting portion and having an opening  
5 provided in a direction in which air flows due to rotation of the rotating recording medium, is further formed.

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75. The method as claimed in claim 74, wherein said bank portion has a tapered portion, inclined from a rotating-recording-medium-coming-in side  
15 of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at an end thereof in a rotating-recording-medium-going-out direction.

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76. The method as claimed in claim 74, wherein said bank portion has a tapered portion,  
25 inclined from a rotating-recording-medium-coming-in side

of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at a bank thereof in a rotating-recording-medium-coming-in direction.

5

77. The method as claimed in claim 74,  
10 wherein said bank portion has a tapered portion, inclined in a radial direction of the rotating recording medium, at a bank(s) approximately parallel to a rotating-recording-medium-coming-in direction.

15

78. The method as claimed in claim 74,  
wherein a length between an end of said first substrate  
20 in a rotating-recording-medium-going-out direction and a tip of said projecting portion is determined based on a thickness thereof, a refractive index thereof and a numerical aperture of an optical component from which light is incident.

25

79. The method as claimed in claim 70,  
wherein:

said probe is such that a rotating recording  
medium on which information is recorded is arranged at a  
5 tip of said projecting portion; and

etching is performed on the same low-  
concentration layer, and, said projecting portion, a  
bank portion arranged to surround said projecting  
portion and a pad portion coming into contact with the  
10 rotating recording medium are formed on a side of said  
first substrate facing the rotating recording medium.

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80. The method as claimed in claim 79,  
wherein said pad portion is formed at a central position  
between a rotating-recording-medium-coming-in end and a  
rotating-recording-medium-going-out end of said first  
20 substrate, or at a position in a range between  $\pm 0.1$   
from said central position assuming that an entire  
length of said first substrate is 1.

25

81. The method as claimed in claim 70,  
wherein, after said patterning material is removed, a  
light-blocking film is formed on said projecting portion  
and a side of said substrate on which said projecting  
5 portion is formed, or only on said projecting portion.

10 82. The method as claimed in claim 70,  
wherein, after said patterning material is removed, a  
light-blocking film is formed on an inclined surface of  
said projecting portion and a side of said substrate on  
which said projecting portion is formed, or only on the  
15 inclined surface of said projecting portion.

20 83. The method as claimed in claim 70,  
wherein, when said patterning material is formed, said  
intermediate layer is to have a predetermined thickness  
at a position of a tip of said projecting portion to be  
made and said intermediate layer at positions other than  
25 that of the tip of said projecting portion is to have a

thickness equal to or smaller than said predetermined thickness

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84. A method of manufacturing a probe comprising the steps of:

10 a) bonding together a first substrate having a property of transmitting light and a second substrate comprising a n-type Si layer having a refractive index higher than that of said first substrate and a p-type Si layer, in a condition in which said first substrate and said n-type Si layer are in contact with one another;

15 b) removing said p-type Si layer included in said second substrate;

20 c) forming a patterning material on a surface of said n-type Si layer exposed as a result of said p-type Si layer being removed and patterning by said patterning material;

d) etching said n-type Si layer using the patterned patterning material so as to form a cone-like or pyramid-like projecting portion on said first substrate; and

25 e) removing the patterned patterning material

so that the probe having the cone-like or pyramid-like projecting portion made from said n-type Si layer on said first substrate be obtained.

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85. The method as claimed in claim 84,  
wherein, in the etching, the projecting portion is  
10 formed so as to have a plurality of tapering angles on  
an outer wall thereof.

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86. The method as claimed in claim 84,  
wherein, in the etching, a bank portion having the same  
height as that of said projecting portion and arranged  
to surround said projecting portion is further formed.

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87. The method as claimed in claim 84,  
25 wherein etching is performed on the same n-type Si layer

and a bank portion made of the same material as that of said projecting portion and arranged to surround said projecting portion is further formed.

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88. The method as claimed in claim 84,  
wherein:

10           said probe is such that a rotating recording medium, on which information is recorded, is arranged at a tip of said projecting portion; and

              in the etching, a bank portion arranged to surround said projecting portion and having an opening  
15   provided in a direction in which air flows due to rotation of the rotating recording medium, is further formed.

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89. The method as claimed in claim 88,  
wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
25   of said first substrate to a rotating-recording-medium-

going-out side of said first substrate, at an end thereof in a rotating-recording-medium-going-out direction.

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90. The method as claimed in claim 88, wherein said bank portion has a tapered portion, inclined from a rotating-recording-medium-coming-in side of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at a bank thereof in a rotating-recording-medium-coming-in direction.

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91. The method as claimed in claim 88, wherein said bank portion has a tapered portion, inclined in a radial direction of the rotating recording medium, at a bank(s) approximately parallel to a rotating-recording-medium-coming-in direction.

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92. The method as claimed in claim 88,  
wherein a length between an end of said first substrate  
in a rotating-recording-medium-going-out direction and a  
tip of said projecting portion is determined based on a  
5 thickness thereof, a refractive index thereof and a  
numerical aperture of an optical component from which  
light is incident.

10

93. The method as claimed in claim 84,  
wherein:

said probe is such that a rotating recording  
15 medium on which information is recorded is arranged at a  
tip of said projecting portion; and

etching is performed on the same n-type Si  
layer, and, said projecting portion, a bank portion  
arranged to surround said projecting portion and a pad  
20 portion coming into contact with the rotating recording  
medium are formed on a side of said first substrate  
facing the rotating recording medium.

25

94. The method as claimed in claim 93,  
wherein said pad portion is formed at a central position  
between a rotating-recording-medium-coming-in end and a  
rotating-recording-medium-going-out end of said first  
5 substrate, or at a position in a range between  $\pm 0.1$   
from said central position assuming that an entire  
length of said first substrate is 1.

10

95. The method as claimed in claim 84,  
wherein, after said patterning material is removed, a  
light-blocking film is formed on said projecting portion  
15 and a side of said substrate on which said projecting  
portion is formed, or only on said projecting portion.

20

96. The method as claimed in claim 84,  
wherein, after said patterning material is removed, a  
light-blocking film is formed on an inclined surface of  
said projecting portion and a side of said substrate on  
25 which said projecting portion is formed, or only on the

inclined surface of said projecting portion.

5

97. The method as claimed in claim 84,  
wherein, when said patterning material is formed, said  
intermediate layer is to have a predetermined thickness  
at a position of a tip of said projecting portion to be  
10 made and said intermediate layer at positions other than  
that of the tip of said projecting portion is to have a  
thickness equal to or smaller than said predetermined  
thickness

15

98. A method of manufacturing a probe  
comprising the steps of:  
20 a) bonding together a first substrate having a  
property of transmitting light and a second substrate  
comprising a high-concentration p-type Si layer having a  
refractive index higher than that of said first  
substrate and an n-type Si layer, in a condition in  
25 which said first substrate and said high-concentration

p-type Si layer are in contact with one another;

b) removing said n-type Si layer included in said second substrate;

c) forming a patterning material on a surface  
5 of said high-concentration p-type Si layer exposed as a result of said n-type Si layer being removed and patterning by said patterning material;

d) etching said high-concentration p-type Si layer using the patterned patterning material so as to  
10 form a cone-like or pyramid-like projecting portion on said first substrate; and

e) removing the patterned patterning material so that the prove having the cone-like or pyramid-like projecting portion made from said high-concentration p-  
15 type Si layer on said first substrate be obtained.

20 99. The method as claimed in claim 98, wherein, in the etching, the projecting portion is formed so as to have a plurality of tapering angles on an outer wall thereof.

100. The method as claimed in claim 98,  
wherein, in the etching, a bank portion having the same  
height as that of said projecting portion and arranged  
to surround said projecting portion is further formed.

5

101. The method as claimed in claim 98,  
10 wherein etching is performed on the same high-  
concentration p-type Si layer and a bank portion made of  
the same material as that of said projecting portion and  
arranged to surround said projecting portion is further  
formed.

15

102. The method as claimed in claim 98,  
20 wherein:

said probe is such that a rotating recording  
medium, on which information is recorded, is arranged at  
a tip of said projecting portion; and

in the etching, a bank portion arranged to  
25 surround said projecting portion and having an opening

provided in a direction in which air flows due to rotation of the rotating recording medium, is further formed.

5

103. The method as claimed in claim 102,  
wherein said bank portion has a tapered portion,  
10 inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
going-out side of said first substrate, at an end  
thereof in a rotating-recording-medium-going-out  
direction.

15

104. The method as claimed in claim 102,  
20 wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
going-out side of said first substrate, at a bank  
thereof in a rotating-recording-medium-coming-in  
25 direction.

105. The method as claimed in claim 102,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording  
medium, at a bank(s) approximately parallel to a  
5 rotating-recording-medium-coming-in direction.

10 106. The method as claimed in claim 102,  
wherein a length between an end of said first substrate  
in a rotating-recording-medium-going-out direction and a  
tip of said projecting portion is determined based on a  
thickness thereof, a refractive index thereof and a  
15 numerical aperture of an optical component from which  
light is incident.

20 107. The method as claimed in claim 98,  
wherein:  
said probe is such that a rotating recording  
medium on which information is recorded is arranged at a  
25 tip of said projecting portion; and

etching is performed on the same high-concentration p-type Si layer, and, said projecting portion, a bank portion arranged to surround said projecting portion and a pad portion coming into contact  
5 with the rotating recording medium are formed on a side of said first substrate facing the rotating recording medium.

10

108. The method as claimed in claim 107, wherein said pad portion is formed at a central position between a rotating-recording-medium-coming-in end and a  
15 rotating-recording-medium-going-out end of said first substrate, or at a position in a range between  $\pm 0.1$  from said central position assuming that an entire length of said first substrate is 1.

20

109. The method as claimed in claim 98, wherein, after said patterning material is removed, a  
25 light-blocking film is formed on said projecting portion

and a side of said substrate on which said projecting portion is formed, or only on said projecting portion.

5

110. The method as claimed in claim 98, wherein, after said patterning material is removed, a light-blocking film is formed on an inclined surface of said projecting portion and a side of said substrate on which said projecting portion is formed, or only on the inclined surface of said projecting portion.

15

111. The method as claimed in claim 98, wherein, when said patterning material is formed, said intermediate layer is to have a predetermined thickness at a position of a tip of said projecting portion to be made and said intermediate layer at positions other than that of the tip of said projecting portion is to have a thickness equal to or smaller than said predetermined thickness

25

112. A probe array comprising:

a substrate having a property of transmitting light; and

5 a plurality of projecting portions formed on said substrate, made of a material having a refractive index higher than that of said substrate, and like cones or pyramids having tips, positions of which are aligned,

wherein each of said plurality of projecting portions has light from said substrate incident thereon,  
10 and generates one of or both an optical near-field and propagation light at the tip thereof.

15

113. The probe array as claimed in claim 112, wherein each of said plurality of projecting portions is made of a single-crystal material having a refractive index higher than that of said substrate.

20

114. The probe array as claimed in claim 112,  
25 wherein each of said plurality of projecting portions is

made of a single-crystal Si (silicon) having a refractive index higher than that of said substrate.

5

115. The probe array as claimed in claim 112, wherein each of said plurality of projecting portions is made from a Gap layer.

10

116. The probe array as claimed in claim 112, wherein each of said plurality of projecting portions is made of a material obtained as a result of a predetermined amount of impurities being mixed to a material having a refractive index higher than that of said substrate.

20

117. The probe array as claimed in claim 112, wherein each of said plurality of projecting portions is

25

made of an n-type Si material having a refractive index higher than that of said substrate.

5

118. The probe array as claimed in claim 112, wherein each of said plurality of projecting portions is made of a high-concentration p-type Si material having a refractive index higher than that of said substrate.

119. The probe array as claimed in claim 112, wherein each of said plurality of projecting portions has a plurality of tapering angles on an outer wall thereof.

20

120. The probe array as claimed in claim 112, further comprising a bank portion having the same height as that of said plurality of projecting portions and

25

arranged to surround said plurality of projecting portions.

5

121. The probe array as claimed in claim 112, further comprising a bank portion made of the same material as that of said plurality of projecting portions and arranged to surround said plurality of projecting portions.

15

122. The probe array as claimed in claim 112, wherein:

a rotating recording medium, on which information is recorded, is arranged at the tips of said plurality of projecting portions; and

said probe array further comprises a bank portion arranged to surround said plurality of projecting portions and having an opening provided in a direction in which air flows due to rotation of the rotating recording medium.

25

123. The probe array as claimed in claim 122,  
wherein each of said plurality of projecting portions is  
located at a position such that a tip of each of said  
plurality of projecting portions and an end of said bank  
5 portion in a rotating-recording-medium-going-out  
direction coincide with one another in a direction  
perpendicular to a rotating-recording-medium-coming-in  
direction, or at a position such that said tip of each  
of said plurality of projecting portions is located on a  
10 rotating-recording-medium-coming-in side of said end of  
said bank portion.

15

124. The probe array as claimed in claim 122,  
wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said substrate to a rotating-recording-medium-going-  
20 out side of said substrate, at an end thereof in a  
rotating-recording-medium-going-out direction.

25

125. The probe array as claimed in claim 122,  
wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said substrate to a rotating-recording-medium-going-  
5 out side of said substrate, at a bank thereof in a  
rotating-recording-medium-coming-in direction.

10

126. The probe array as claimed in claim 122,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording  
medium, at a bank(s) approximately parallel to a  
15 rotating-recording-medium-coming-in direction.

20

127. The probe array as claimed in claim 122,  
wherein a length between an end of said substrate in a  
rotating-recording-medium-going-out direction and the  
tip of each of said plurality of projecting portions is  
determined based on a thickness thereof, a refractive  
25 index thereof and a numerical aperture of an optical

component from which light is incident.

5

128. The probe array as claimed in claim 112,  
wherein:

a rotating recording medium, on which  
information is recorded, is arranged at the tips of said  
10 plurality of projecting portions; and

said probe array further comprises: a bank  
portion made of the same material as that of said  
plurality of projecting portions, and arranged to  
surround said plurality of projecting portions; and a  
15 pad portion made of the same material as that of said  
plurality of projecting portions, and coming into  
contact with the rotating recording medium.

20

129. The probe array as claimed in claim 128,  
wherein said pad portion is formed at a central position  
between a rotating-recording-medium-coming-in end and a  
25 rotating-recording-medium-going-out end of said

substrate, or at a position in a range between  $\pm 0.1$   
from said central position assuming that an entire  
length of said substrate is 1.

5

130. The probe array as claimed in claim 112,  
wherein a light-blocking film is formed on each of said  
10 plurality of projecting portions and a side of said  
substrate on which said plurality of projecting portions  
are formed, or only on each of said plurality of  
projecting portions.

15

131. The probe array as claimed in claim 112,  
wherein a light-blocking film is formed on an inclined  
20 surface of each of said plurality of projecting portions  
and a side of said substrate on which said plurality of  
projecting portions are formed, or only on the inclined  
surface of each of said plurality of projecting portions.

25

132. A method of manufacturing a probe array comprising the steps of:

- a) bonding together a first substrate having a property of transmitting light and a second substrate comprising a high-refractive-index layer having a refractive index higher than that of said first substrate, an intermediate layer layered on said high-refractive-index layer and a supporting layer layered on said intermediate layer, in a condition in which said first substrate is in contact with said high-refractive-index layer;
- b) removing said supporting layer included in said second substrate;
- c) patterning by said intermediate layer exposed as a result of said supporting layer being removed;
- d) etching said high-refractive-index layer using the patterned intermediate layer so as to form a plurality of cone-like or pyramid-like projecting portions on said first substrate; and
- e) removing the patterned intermediate layer so that the probe array having the plurality of cone-like or pyramid-like projecting portions made from said high-refractive-index layer on said first substrate be obtained.

133. The method as claimed in claim 132,  
wherein said high-refractive-index layer is of Si and  
said intermediate layer is of SiO<sub>2</sub>.

5

134. The method as claimed in claim 132,  
wherein said high-refractive-index layer is of GaP and  
10 said intermediate layer is of SiO<sub>2</sub>.

15 135. The method as claimed in claim 132,  
wherein said high-refractive-index layer is of a single-  
crystal material, said intermediate layer is of SiO<sub>2</sub> and  
said supporting layer is of Si.

20

136. The method as claimed in claim 132,  
wherein said high-refractive-index layer is of a single-  
25 crystal Si, said intermediate layer is of SiO<sub>2</sub> and said

supporting layer is of Si.

5

137. The method as claimed in claim 132, wherein, in the etching, each of the plurality of projecting portions is formed so as to have a plurality of tapering angles on an outer wall thereof.

10

138. The method as claimed in claim 132, wherein, in the etching, a bank portion having the same height as that of said plurality of projecting portions and arranged to surround said plurality of projecting portions is further formed.

20

139. The method as claimed in claim 132, wherein etching is performed on the same high-refractive-index layer and a bank portion having the

25

same height as that of said plurality of projecting portions and arranged to surround said plurality of projecting portions is further formed.

5

140. The method as claimed in claim 132, wherein:

10           said probe array is such that a rotating recording medium, on which information is recorded, is arranged at tips of said plurality of projecting portions; and

              in the etching, a bank portion arranged to  
15 surround said plurality of projecting portions and having an opening provided in a direction in which air flows due to rotation of the rotating recording medium, is further formed.

20

141. The method as claimed in claim 140, wherein said bank portion has a tapered portion,  
25 inclined from a rotating-recording-medium-coming-in side

of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at an end thereof in a rotating-recording-medium-going-out direction.

5

142. The method as claimed in claim 140,  
10 wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at a bank thereof in a rotating-recording-medium-coming-in  
15 direction.

20 143. The method as claimed in claim 140,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording medium, at a bank(s) approximately parallel to a rotating-recording-medium-coming-in direction.

25

144. The method as claimed in claim 140,  
wherein a length of said first substrate in a rotating-  
recording-medium-moving direction is determined based on  
a thickness thereof, a refractive index thereof and a  
5 numerical aperture of an optical component from which  
light is incident.

10

145. The method as claimed in claim 132,  
wherein:

said probe array is such that a rotating  
recording medium on which information is recorded is  
15 arranged at tips of said plurality of projecting  
portions; and

etching is performed on the same high-  
refractive-index layer, and, said plurality of  
projecting portions, a bank portion arranged to surround  
20 said plurality of projecting portions and a pad portion  
coming into contact with the rotating recording medium  
are formed on a side of said first substrate facing the  
rotating recording medium.

25

146. The method as claimed in claim 145,  
wherein said pad portion is formed at a central position  
between a rotating-recording-medium-coming-in end and a  
rotating-recording-medium-going-out end of said first  
5 substrate, or at a position in a range between  $\pm 0.1$   
from said central position assuming that an entire  
length of said first substrate is 1.

10

147. The method as claimed in claim 132,  
wherein, after said intermediate layer is removed, a  
light-blocking film is formed on each of said plurality  
15 of projecting portions and a side of said substrate on  
which said plurality of projecting portions are formed,  
or only on each of said plurality of projecting portions.

20

148. The method as claimed in claim 132,  
wherein, after said intermediate layer is removed, a  
light-blocking film is formed on an inclined surface of  
25 each of said plurality of projecting portions and a side

of said substrate on which said plurality of projecting portions are formed, or only on the inclined surface of each of said plurality of projecting portions.

5

149. The method as claimed in claim 132, wherein, when patterning is performed by said  
10 intermediate layer, said intermediate layer is to have a predetermined thickness at positions of respective tips of said plurality of projecting portions to be made and said intermediate layer at positions other than those of the respective tips of said plurality of projecting  
15 portions is to have a thickness equal to or smaller than said predetermined thickness.

20

150. A method of manufacturing a probe array comprising the steps of:

a) bonding together a first substrate having a property of transmitting light and a second substrate  
25 comprising a supporting layer, an intermediate layer

formed on said supporting layer and a GaP layer formed on said intermediate layer, in a condition in which said first substrate and said GaP layer are in contact with one another;

5                   b) removing said supporting layer included in said second substrate;

                  c) patterning by said intermediate layer exposed as a result of said supporting layer being removed;

10                   d) etching said GaP layer using the patterned intermediate layer so as to form a plurality of cone-like or pyramid-like projecting portions on said first substrate; and

                  e) removing the patterned intermediate layer  
15 so that the probe array having the plurality of cone-like or pyramid-like projecting portions made from said GaP layer on said first substrate be obtained.

20

151. The method as claimed in claim 150,  
wherein, in the etching, each of the plurality of  
projecting portions is formed so as to have a plurality  
25 of tapering angles on an outer wall thereof.

152. The method as claimed in claim 150,  
wherein, in the etching, a bank portion having the same  
height as that of said plurality of projecting portions  
and arranged to surround said plurality of projecting  
5 portions is further formed.

10 153. The method as claimed in claim 150,  
wherein etching is performed on the same GaP layer and a  
bank portion made of the same material as that of said  
plurality of projecting portions and arranged to  
surround said plurality of projecting portions is  
15 further formed.

20 154. The method as claimed in claim 150,  
wherein:  
said probe array is such that a rotating  
recording medium, on which information is recorded, is  
arranged at tips of said plurality of projecting  
25 portions; and

in the etching, a bank portion arranged to surround said plurality of projecting portions and having an opening provided in a direction in which air flows due to rotation of the rotating recording medium,  
5 is further formed.

10 155. The method as claimed in claim 154, wherein said bank portion has a tapered portion, inclined from a rotating-recording-medium-coming-in side of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at an end  
15 thereof in a rotating-recording-medium-going-out direction.

20 156. The method as claimed in claim 154, wherein said bank portion has a tapered portion, inclined from a rotating-recording-medium-coming-in side of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at a bank  
25

thereof in a rotating-recording-medium-coming-in  
direction.

5

157. The method as claimed in claim 154,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording  
10 medium, at a bank(s) approximately parallel to a  
rotating-recording-medium-coming-in direction.

15

158. The method as claimed in claim 154,  
wherein a length of said first substrate in a rotating-  
recording-medium-moving direction is determined based on  
a thickness thereof, a refractive index thereof and a  
20 numerical aperture of an optical component from which  
light is incident.

25

159. The method as claimed in claim 150,  
wherein:

said probe array is such that a rotating  
recording medium on which information is recorded is  
5 arranged at tips of said plurality of projecting  
portions; and

etching is performed on the same GaP layer,  
and, said plurality of projecting portions, a bank  
portion arranged to surround said plurality of  
10 projecting portions and a pad portion coming into  
contact with the rotating recording medium are formed on  
a side of said first substrate facing the rotating  
recording medium.

15

160. The method as claimed in claim 159,  
wherein said pad portion is formed at a central position  
20 between a rotating-recording-medium-coming-in end and a  
rotating-recording-medium-going-out end of said first  
substrate, or at a position in a range between  $\pm 0.1$   
from said central position assuming that an entire  
length of said first substrate is 1.

25

161. The method as claimed in claim 150,  
wherein, after said intermediate layer is removed, a  
light-blocking film is formed on each of said plurality  
of projecting portions and a side of said substrate on  
5 which said plurality of projecting portions are formed,  
or only on each of said plurality of projecting portions.

10

162. The method as claimed in claim 150,  
wherein, after said intermediate layer is removed, a  
light-blocking film is formed on an inclined surface of  
each of said plurality of projecting portions and a side  
15 of said substrate on which said plurality of projecting  
portions are formed, or only on the inclined surface of  
each of said plurality of projecting portions.

20

163. The method as claimed in claim 150,  
wherein, when patterning is performed by said  
intermediate layer, said intermediate layer is to have a  
25 predetermined thickness at positions of respective tips

of said plurality of projecting portions to be made and  
said intermediate layer at positions other than those of  
the respective tips of said plurality of projecting  
portions is to have a thickness equal to or smaller than  
5 said predetermined thickness

10 164. A method of manufacturing a probe array  
comprising the steps of:

a) bonding together a first substrate having a  
property of transmitting light and a second substrate  
comprising a low-concentration layer having a refractive  
15 index higher than that of said first substrate and  
having a predetermined amount of impurities mixed  
therein and a high-concentration layer having impurities  
more than said predetermined amount of impurities mixed  
therein, in a condition in which said first substrate  
20 and said low-concentration layer are in contact with one  
another;

b) removing said high-concentration layer  
included in said second substrate;

c) forming a patterning material on a surface  
25 of said low-concentration layer exposed as a result of

said high-concentration layer being removed and  
patterning by said patterning material;

d) etching said low-concentration layer  
exposed by the patterning so as to form a plurality of  
5 cone-like or pyramid-like projecting portions on said  
first substrate; and

e) removing the patterned patterning material  
so that the probe array having the plurality of cone-  
like or pyramid-like projecting portions made from said  
10 low-concentration layer on said first substrate be  
obtained.

15

165. The method as claimed in claim 164,  
wherein, in the etching, each of the plurality of  
projecting portions is formed so as to have a plurality  
of tapering angles on an outer wall thereof.

20

166. The method as claimed in claim 164,  
25 wherein, in the etching, a bank portion having the same

height as that of said plurality of projecting portions and arranged to surround said plurality of projecting portions is further formed.

5

167. The method as claimed in claim 164, wherein etching is performed on the same low-  
10 concentration layer and a bank portion made of the same material as that of said plurality of projecting portions and arranged to surround said plurality of projecting portions is further formed.

15

168. The method as claimed in claim 164, wherein:

20 said probe array is such that a rotating recording medium, on which information is recorded, is arranged at tips of said plurality of projecting portions; and

in the etching, a bank portion arranged to  
25 surround said plurality of projecting portions and

having an opening provided in a direction in which air flows due to rotation of the rotating recording medium, is further formed.

5

169. The method as claimed in claim 168, wherein said bank portion has a tapered portion,  
10 inclined from a rotating-recording-medium-coming-in side of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at an end thereof in a rotating-recording-medium-going-out direction.

15

170. The method as claimed in claim 168,  
20 wherein said bank portion has a tapered portion, inclined from a rotating-recording-medium-coming-in side of said first substrate to a rotating-recording-medium-going-out side of said first substrate, at a bank thereof in a rotating-recording-medium-coming-in  
25 direction.

171. The method as claimed in claim 168,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording  
medium, at a bank(s) approximately parallel to a  
5 rotating-recording-medium-coming-in direction.

10 172. The method as claimed in claim 168,  
wherein a length of said first substrate in a rotating-  
recording-medium-moving direction is determined based on  
a thickness thereof, a refractive index thereof and a  
numerical aperture of an optical component from which  
15 light is incident.

20 173. The method as claimed in claim 164,  
wherein:  
said probe array is such that a rotating  
recording medium on which information is recorded is  
arranged at tips of said plurality of projecting  
25 portions; and

etching is performed on the same low-concentration layer, and, said plurality of projecting portions, a bank portion arranged to surround said plurality of projecting portions and a pad portion coming into contact with the rotating recording medium are formed on a side of said first substrate facing the rotating recording medium.

10

174. The method as claimed in claim 173, wherein said pad portion is formed at a central position between a rotating-recording-medium-coming-in end and a rotating-recording-medium-going-out end of said first substrate, or at a position in a range between  $\pm 0.1$  from said central position assuming that an entire length of said first substrate is 1.

20

175. The method as claimed in claim 164, wherein, after said patterning material is removed, a light-blocking film is formed on each of said plurality

25

of projecting portions and a side of said substrate on which said plurality of projecting portions are formed, or only on each of said plurality of projecting portions.

5

176. The method as claimed in claim 164, wherein, after said patterning material is removed, a  
10 light-blocking film is formed on an inclined surface of each of said plurality of projecting portions and a side of said substrate on which said plurality of projecting portions are formed, or only on the inclined surface of each of said plurality of projecting portions.

15

177. The method as claimed in claim 164,  
20 wherein, when said patterning material is formed, said intermediate layer is to have a predetermined thickness at positions of respective tips of said plurality of projecting portions to be made and said intermediate layer at positions other than those of the respective  
25 tips of said plurality of projecting portions is to have

a thickness equal to or smaller than said predetermined thickness

5

178. A method of manufacturing a probe array comprising the steps of:

- 10 a) bonding together a first substrate having a property of transmitting light and a second substrate comprising a n-type Si layer having a refractive index higher than that of said first substrate and a p-type Si layer, in a condition in which said first substrate and said n-type Si layer are in contact with one another;
- 15 b) removing said p-type Si layer included in said second substrate;
- c) forming a patterning material on a surface of said n-type Si layer exposed as a result of said p-type Si layer being removed and patterning by said
- 20 patterning material;
- d) etching said n-type Si layer using the patterned patterning material so as to form a plurality of cone-like or pyramid-like projecting portions on said first substrate; and
- 25 e) removing the patterned patterning material

so that the probe array having the plurality of cone-like or pyramid-like projecting portions made from said n-type Si layer on said first substrate be obtained.

5

179. The method as claimed in claim 178, wherein, in the etching, each of the plurality of  
10 projecting portions is formed so as to have a plurality of tapering angles on an outer wall thereof.

15

180. The method as claimed in claim 178, wherein, in the etching, a bank portion having the same height as that of said plurality of projecting portions and arranged to surround said plurality of projecting  
20 portions is further formed.

25

181. The method as claimed in claim 178,

wherein etching is performed on the same n-type Si layer  
and a bank portion made of the same material as that of  
said plurality of projecting portions and arranged to  
surround said plurality of projecting portions is  
5 further formed.

10 182. The method as claimed in claim 178,  
wherein:

said probe array is such that a rotating  
recording medium, on which information is recorded, is  
arranged at tips of said plurality of projecting  
15 portions; and

in the etching, a bank portion arranged to  
surround said plurality of projecting portions and  
having an opening provided in a direction in which air  
flows due to rotation of the rotating recording medium,  
20 is further formed.

25 183. The method as claimed in claim 182,

wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
going-out side of said first substrate, at an end  
5 thereof in a rotating-recording-medium-going-out  
direction.

10

184. The method as claimed in claim 182,  
wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
15 going-out side of said first substrate, at a bank  
thereof in a rotating-recording-medium-coming-in  
direction.

20

185. The method as claimed in claim 182,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording  
25 medium, at a bank(s) approximately parallel to a

rotating-recording-medium-coming-in direction.

5

186. The method as claimed in claim 182,  
wherein a length of said first substrate in a rotating-  
recording-medium-moving direction is determined based on  
a thickness thereof, a refractive index thereof and a  
10 numerical aperture of an optical component from which  
light is incident.

15

187. The method as claimed in claim 178,  
wherein:

said probe array is such that a rotating  
recording medium on which information is recorded is  
20 arranged at tips of said plurality of projecting  
portions; and

etching is performed on the same n-type Si  
layer, and, said plurality of projecting portions, a  
bank portion arranged to surround said plurality of  
25 projecting portions and a pad portion coming into

contact with the rotating recording medium are formed on a side of said first substrate facing the rotating recording medium.

5

188. The method as claimed in claim 187, wherein said pad portion is formed at a central position between a rotating-recording-medium-coming-in end and a rotating-recording-medium-going-out end of said first substrate, or at a position in a range between  $\pm 0.1$  from said central position assuming that an entire length of said first substrate is 1.

15

189. The method as claimed in claim 178, wherein, after said patterning material is removed, a light-blocking film is formed on each of said plurality of projecting portions and a side of said substrate on which said plurality of projecting portions are formed, or only on each of said plurality of projecting portions.

25

190. The method as claimed in claim 178,  
wherein, after said patterning material is removed, a  
light-blocking film is formed on an inclined surface of  
each of said plurality of projecting portions and a side  
5 of said substrate on which said plurality of projecting  
portions are formed, or only on the inclined surface of  
each of said plurality of projecting portions.

10

191. The method as claimed in claim 178,  
wherein, when said patterning material is formed, said  
intermediate layer is to have a predetermined thickness  
15 at positions of respective tips of said plurality of  
projecting portions to be made and said intermediate  
layer at positions other than those of the respective  
tips of said plurality of projecting portions is to have  
a thickness equal to or smaller than said predetermined  
20 thickness

25

192. A method of manufacturing a probe array

comprising the steps of:

a) bonding together a first substrate having a property of transmitting light and a second substrate comprising a high-concentration p-type Si layer having a refractive index higher than that of said first substrate and an n-type Si layer, in a condition in which said first substrate and said high-concentration p-type Si layer are in contact with one another;

b) removing said n-type Si layer included in said second substrate;

c) forming a patterning material on a surface of said high-concentration p-type Si layer exposed as a result of said n-type Si layer being removed and patterning by said patterning material;

d) etching said high-concentration p-type Si layer using the patterned patterning material so as to form a plurality of cone-like or pyramid-like projecting portions on said first substrate; and

e) removing the patterned patterning material so that the probe array having the plurality of cone-like or pyramid-like projecting portions made from said high-concentration p-type Si layer on said first substrate be obtained.

193. The method as claimed in claim 192,  
wherein, in the etching, each of the plurality of  
projecting portions is formed so as to have a plurality  
of tapering angles on an outer wall thereof.

5

194. The method as claimed in claim 192,  
10 wherein, in the etching, a bank portion having the same  
height as that of said plurality of projecting portions  
and arranged to surround said plurality of projecting  
portions is further formed.

15

195. The method as claimed in claim 192,  
wherein etching is performed on the same high-  
20 concentration p-type Si layer and a bank portion made of  
the same material as that of said plurality of  
projecting portions and arranged to surround said  
plurality of projecting portions is further formed.

25

196. The method as claimed in claim 192,  
wherein:

said probe array is such that a rotating  
recording medium, on which information is recorded, is  
5 arranged at tips of said plurality of projecting  
portions; and

in the etching, a bank portion arranged to  
surround said plurality of projecting portions and  
having an opening provided in a direction in which air  
10 flows due to rotation of the rotating recording medium,  
is further formed.

15

197. The method as claimed in claim 196,  
wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
20 going-out side of said first substrate, at an end  
thereof in a rotating-recording-medium-going-out  
direction.

25

198. The method as claimed in claim 196,  
wherein said bank portion has a tapered portion,  
inclined from a rotating-recording-medium-coming-in side  
of said first substrate to a rotating-recording-medium-  
5 going-out side of said first substrate, at a bank  
thereof in a rotating-recording-medium-coming-in  
direction.

10

199. The method as claimed in claim 196,  
wherein said bank portion has a tapered portion,  
inclined in a radial direction of the rotating recording  
15 medium, at a bank(s) approximately parallel to a  
rotating-recording-medium-coming-in direction.

20

200. The method as claimed in claim 196,  
wherein a length of said first substrate in a rotating-  
recording-medium-moving direction is determined based on  
a thickness thereof, a refractive index thereof and a  
25 numerical aperture of an optical component from which

light is incident.

5

201. The method as claimed in claim 192,  
wherein:

said probe array is such that a rotating  
recording medium on which information is recorded is  
10 arranged at tips of said plurality of projecting  
portions; and

etching is performed on the same high-  
concentration p-type Si layer, and, said plurality of  
projecting portions, a bank portion arranged to surround  
15 said plurality of projecting portions and a pad portion  
coming into contact with the rotating recording medium  
are formed on a side of said first substrate facing the  
rotating recording medium.

20

202. The method as claimed in claim 201,  
wherein said pad portion is formed at a central position  
25 between a rotating-recording-medium-coming-in end and a

rotating-recording-medium-going-out end of said first substrate, or at a position in a range between  $\pm 0.1$  from said central position assuming that an entire length of said first substrate is 1.

5

203. The method as claimed in claim 192,  
10 wherein, after said patterning material is removed, a light-blocking film is formed on each of said plurality of projecting portions and a side of said substrate on which said plurality of projecting portions are formed, or only on each of said plurality of projecting portions.

15

204. The method as claimed in claim 192,  
20 wherein, after said patterning material is removed, a light-blocking film is formed on an inclined surface of each of said plurality of projecting portions and a side of said substrate on which said plurality of projecting portions are formed, or only on the inclined surface of  
25 each of said plurality of projecting portions.

205. The method as claimed in claim 192,  
wherein, when said patterning material is formed, said  
intermediate layer is to have a predetermined thickness  
at positions of respective tips of said plurality of  
5 projecting portions to be made and said intermediate  
layer at positions other than those of the respective  
tips of said plurality of projecting portions is to have  
a thickness equal to or smaller than said predetermined  
thickness.